

CLAIMS

- 1 1. An evaporator unit comprising:
- 2 A) a feed inlet into which an inlet flow of liquid can be introduced;
- 3 B) a heat exchanger including heat-transfer surfaces that form at least one
- 4 evaporation chamber into which liquid can be introduced to evaporate it;
- 5 C) a make-up-liquid guide that defines a make-up path along which it directs
- 6 liquid from the inlet to the at least one evaporation chamber;
- 7 D) a filter so interposed in the make-up path as to filter liquid that flows
- 8 therethrough;
- 9 E) a recirculation guide that defines a recirculation path along which it re-
- 10 turns to the at least one evaporation chamber liquid that has passed
- 11 through the at least one evaporation chamber without evaporating; and
- 12 F) a transfer valve interposed in the recirculation path and operable between:
- 13 i) a recirculation state, in which it permits liquid that has passed
- 14 through the at least one evaporation chamber without evaporating
- 15 to return along the recirculation path to the at least one evaporation
- 16 chamber; and
- 17 ii) a flush state, in which it diverts liquid from the recirculation path
- 18 into the filter.
- 1 2. An evaporator unit as defined in claim 1 further including:
- 2 A) a refresh-liquid reservoir;
- 3 B) a feed-liquid-storage guide that defines a feed-liquid-storage path along
- 4 which it directs liquid from the feed inlet into the refresh-liquid reservoir
- 5 while the transfer valve is in its recirculation state; and
- 6 C) a refresh guide that defines a refresh path along which it directs liquid
- 7 from the refresh-liquid reservoir to the at least one evaporation chamber
- 8 while the transfer valve is in its flush state.

- 1 3. An evaporator unit as defined in claim 1, further including:
2 A) a concentrate reservoir; and
3 B) a concentrate-storage guide defining a concentrate-storage path along
4 which it directs liquid from the liquid collector through the filter into the
5 concentrate reservoir when the transfer valve is in its flush state.
- 1 4. An evaporator unit as defined in claim 3 further including:
2 A) a refresh-liquid reservoir;
3 B) a feed-liquid-storage guide that defines a feed-liquid-storage path along
4 which it directs liquid from the feed inlet into the refresh-liquid reservoir
5 while the transfer valve is in its recirculation state; and
6 C) a refresh guide that defines a refresh path along which it directs liquid
7 from the refresh-liquid reservoir to the at least one evaporation chamber
8 while the transfer valve is in its flush state.
- 1 5. An evaporator unit as defined in claim 4, further including:
2 A) a piston chamber; and
3 B) a piston so movably disposed in the piston chamber as to divide it into the
4 refresh-liquid and concentrate reservoirs.
- 1 6. An evaporator unit as defined in claim 5, further including a valve operator that so
2 operates the transfer valve as alternately to define flush cycles, in which the transfer
3 valve is in its flush state, and recirculation cycles, in which the transfer valve is in its re-
4 circulation state.
- 1 7. An evaporator unit as defined in claim 6 wherein the average duration of the re-
2 circulation cycles is at least fifty times that of the flush cycles.
- 1 8. An evaporator unit as defined in claim 6 wherein the valve operator includes the
2 piston, whose position determines the state of the transfer valve.

- 1 9. An evaporator unit as defined in claim 8 wherein the average duration of the re-
2 circulation cycles is at least fifty times that of the flush cycles.
- 1 10. An evaporator unit as defined in claim 4 wherein the flow of liquid into the con-
2 centrate reservoir while the transfer valve is in its flush state so drives the piston as to re-
3 duce the size of the refresh-liquid reservoir and thereby drive liquid therefrom through
4 the refresh path.
- 1 11. An evaporator unit as defined in claim 4 further including:
2 A) a concentrate outlet; and
3 B) a concentrate-discharge guide defining a concentrate-discharge path along
4 which it directs liquid from the concentrate reservoir to the concentrate
5 outlet while the transfer valve is in its recirculation state.
- 1 12. An evaporator unit as defined in claim 11 wherein the flow of liquid into the con-
2 centrate reservoir while the transfer valve is in its flush state so drives the piston as to re-
3 duce the size of the refresh-liquid reservoir and thereby drive liquid therefrom through
4 the refresh path.
- 1 13. An evaporator unit as defined in claim 1 wherein the heat-transfer surfaces addi-
2 tionally form at least one condensation chamber from which they can conduct heat to the
3 at least one evaporation chamber.
- 1 14. An evaporator unit as defined in claim 13 further including a vapor guide that di-
2 rects along a vapor path from the at least one evaporation chamber to the at least one
3 condensation chamber vapor produced in the evaporation chamber.
- 1 15. An evaporator unit as defined in claim 14 further including a compressor disposed
2 in the vapor path and operable to make the vapor pressure in the at least one condensation
3 chamber greater than that in the at least one evaporation chamber.

1 16. An evaporator unit as defined in claim 1, further including a valve operator that so
2 operates the transfer valve as alternately to define flush cycles, in which the transfer
3 valve is in its flush state, and recirculation cycles, in which the transfer valve is in its re-
4 circulation state.

1 17. An evaporator unit as defined in claim 16 wherein the average duration of the re-
2 circulation cycles is at least fifty times that of the flush cycles.

1 18. For evaporating liquid, a method comprising:

- 2 A) providing an evaporator unit that includes:
- 3 i) a feed inlet into which an inlet flow of liquid can be introduced;
- 4 ii) a heat exchanger including heat-transfer surfaces that form at least
5 one evaporation chamber into which liquid can be introduced to
6 evaporate it;
- 7 iii) a make-up-liquid guide that defines a make-up path along which it
8 directs liquid from the inlet to the at least one evaporation cham-
9 ber;
- 10 iv) a filter so interposed in the make-up path as to filter liquid that
11 flows therethrough;
- 12 B) introducing an inlet flow of liquid into the feed inlet;
- 13 C) during relatively long, recirculation cycles, returning to the at least one
14 evaporation chamber liquid that has passed therethrough without evapo-
15 rating; and
- 16 D) during relatively short, flush cycles, flushing the filter by directing there-
17 into liquid that has passed through the evaporation chamber without
18 evaporating.

1 19. A method as defined in claim 18 wherein the average duration of the recirculation
2 cycles is at least fifty times that of the flush cycles.

1 20. A method as defined in claim 18 wherein the heat-transfer surfaces additionally
2 form at least one condensation chamber from which they can conduct heat to the at least
3 one evaporation chamber.

1 21. A method as defined in claim 20 wherein the method includes directing along a
2 vapor path from the at least one evaporation chamber to the at least one condensation
3 chamber vapor produced in the evaporation chamber.

1 22. A method as defined in claim 21 wherein the method includes so compressing
2 vapor in the vapor path as to make the vapor pressure in the at least one condensation
3 chamber greater than that in the at least one evaporation chamber.

1 23. A method as defined in claim 21 wherein the average duration of the recirculation
2 cycles is at least fifty times that of the flush cycles.

1 24. An apparatus for evaporating liquid comprising:
2 A) a feed inlet into which an inlet flow of liquid can be introduced;
3 B) a heat exchanger including heat-transfer surfaces that form at least one
4 evaporation chamber into which liquid can be introduced to evaporate it;
5 C) a filter;
6 D) means for directing liquid from the inlet along a make-up path through the
7 filter to the at least one evaporation chamber;
8 E) means for, during relatively long, recirculation cycles, returning to the at
9 least one evaporation chamber liquid that has passed therethrough without
10 evaporating; and
11 F) means for, during relatively short, flush cycles, flushing the filter by di-
12 recting therein liquid that has passed through the evaporation chamber
13 without evaporating.

1 25. An apparatus as defined in claim 24 wherein the average duration of the recircu-
2 lation cycles is at least fifty times that of the flush cycles.

1 26. An apparatus as defined in claim 24 wherein the heat-transfer surfaces addition-
2 ally form at least one condensation chamber from which they can conduct heat to the at
3 least one evaporation chamber.

1 27. An apparatus as defined in claim 26 further including means for directing along a
2 vapor path from the at least one evaporation chamber to the at least one condensation
3 chamber vapor produced in the evaporation chamber.

1 28. An apparatus as defined in claim 27 further including means for so compressing
2 vapor in the vapor path as to make the vapor pressure in the at least one condensation
3 chamber greater than that in the at least one evaporation chamber.

1 29. An apparatus as defined in claim 27 wherein the average duration of the recircu-
2 lation cycles is at least fifty times that of the flush cycles.